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AUTHOR Johnson, S. Langham
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ABSTRACT

Although researchers are only now beginning studies of microcomputer use in classrooms, findings concerning the educational use of mainframe computer terminals indicate educational benefits. The available studies suggest guidelines for classroom microcomputer use. These guidelines include developing administrative procedures for evaluating computer software; instituting ground rules for sharing microcomputers; and making plans for introducing the microcomputer into the classroom, for supervision, and for teacher orientation to hardware and software. A microcomputer can be used to (1) teach computer literacy; (2) tutor; (3) teach programming skills; (4) allow students to express themselves, explore, and create; (5) provide opportunities for creative writing; and (6) perform administrative tasks. Practitioners should demand that computer program publishers provide preview privileges. Criteria for selecting software programs should include determining whether the program has been field-tested and is compatible with hardware and instructional objectives; assessing the psychological impact of the program on students; estimating how the program, as a sensory experience, is likely to contribute to students' overall perception of classroom life; identifying the age for which the program's physical features are most appropriate; evaluating the quality of the interactive structure of the program; and assessing the appropriateness of the program in relation to concrete and symbolic experience. (In conclusion, questions for future research are suggested.) (RH)

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HOW TO BE HAPPY WITH MICROCOMPUTERS IN YOUR SCHOOL

by

S. Langham Johnson, Ph.D.
Assistant Professor
Department of Educational Foundations and Inquiry
Bowling Green State University
Bowling Green, Ohio

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INTRODUCTION

In the Spring of 1983 there were approximately 131,000 computers in 25,350 public schools in America. According to an Ohio State University survey, there is an expected increase of this number of 64% by the end of 1983. A Gallop Poll survey in May 1983 showed 3 - 5% of students have home computers, of whom 6% are teenagers. Of sixty million dollars spent on educational software last year, twenty-five million was spent by schools. Private buyers and home computer users account for about thirty million dollars in sales. Computers are here to stay and schools are buying them.

Most of the research on the effects of computers in classrooms has been with main frame computer terminals like PLATO at the University of Illinois. While there have been no longitudinal studies of the consequences of these computer terminals in classrooms, research with main frame terminals shows that 1) students can learn academics as well from a computer as with traditional teaching methods, 2) students enjoy computers, and 3) special groups often benefit greatly from computerized education; e.g., the learning disabled, deaf, bi-lingual, and students who for a variety of reasons have failed using traditional methods, have low self esteem, come from disadvantaged back grounds, etc. M. Siegle's research with computer assisted instruction in prisons of Illinois, for example, has shown that many prison inmates who had been chronic failures in schools can succeed with computerized education.

These benefits appear to be the consequence of rapid feedback provided by effective computer instruction, individual pacing, extended opportunities to practice and privacy in which mistakes are not shared

with a whole class. Hollworth and Brebner (1980) provide a review of studies of elementary and secondary school children using main frame computer systems like PLATO and ICCIT.

Unlike main frame computer research, research in microcomputers in the classroom is only in the beginning stages, with little research focused on young children. For a recent review of this research see Spencer and Baskin (in press) and W. Feurzig (1983). Some of this research suggests answers to the question of how to be happy with microcomputers in the classroom. However, none of it is longitudinal, relating the long term use of the microcomputer and children's academic progress and overall development.

Being happy with computers in the classroom requires first, an understanding of some of the various ways a computer may be used there; second, knowledge of criteria for selecting appropriate software programs to use with the computer; and third, a cautious respect for the unanswered questions related to use and selection that need to be subjected to further research.

USES OF COMPUTERS IN THE CLASSROOM

Who will use the computer(s) and when will they be used? If a school can provide two computers per classroom, it may be helpful to purchase computers made by two different manufacturers whose software programs are compatible. This way a class can benefit from a greater variety of software programs and formats.

It will be helpful at the outset to develop administrative procedures for evaluating computer software. Demand that the publishers of computer programs provide the school with preview privileges. A school media specialist is a logical person to manage equipment,

acquisition of software and to give training and technical assistance to teachers. This can include inservice training on computer use, designed to meet teacher's individual interests and needs. Some concerns might include:

1) Who has priority when machines serve multiple purposes?
2) How much time will be allotted to teaching students about computer programming?
3) How will software be selected, developed, and evaluated?
4) Which students or classes will have priority in use of the computers?

If a single microcomputer is to be shared by a group of twenty-five students, the ground rules for sharing it must be determined in advance of its introduction into the classroom. A reward system in which a small part of the class who complete their academic work are allowed to use the computer as a special privilege or enrichment may neglect students with special learning problems who could benefit from computerized instruction the most. Fifteen minutes a week per student per week on the computer is not enough. One microcomputer per student will be ideal, but may not be financially feasible until the price of computers comes down. One computer per student may be possible in the near future for schools in wealthy districts, if technical trends in the computer industry continue to provide computers at lower costs.

How the computer is introduced into the classroom may make a difference in whether students and teacher are happy using it. If sharing the computer may be a problem, it is imperative to introduce the computer discretely and to have a plan for sharing it. Basic ground rules for use of the computer can be introduced, discussed with

the group and posted. In a class in which the teacher-student ratio is low, the computer can be placed where visual supervision of its use is easily accessible by the teacher. Should the computer(s) be placed behind a screen to reduce distractions from other activities or in a separate room? This may depend on the type of classroom, traditional or open; and the kind of instruction that typically goes on there, secondary, elementary, or preschool.

Children under five years of age may require closer supervision with the microcomputer than older students. All students will require more supervision when the computer is new or when a new software program is first introduced. Software computer discs can be a problem with preschool children because by holding the disc in place, a child can destroy the disc mechanism. Students of any age can be given a one-on-one demonstration of appropriate use of the computer to prevent its accidental or intentional destruction. The amount and consistency of supervision needed thereafter may depend on the age, stage and previous experience of the students with computers, as judged by the teacher. Some students will have used computers at home or elsewhere and may even be able to instruct their peers and the teacher.

Before introducing the microcomputer into the school, plan to spend at least fifteen hours getting comfortable with this new companion-helper. If the teacher is intimidated and uncomfortable with the computer, students may be similarly discouraged. Take whatever time is necessary to learn about the computer and after acquiring a new software program, take time to use it and understand its limitations before making it available to students.

In deciding on the purchase of a microcomputer or software programs for use in the classroom, there are at least six ways you can plan to use the computer. By acquiring appropriate software, all of these applications can be handled by a single computer:

First, computer literacy: This may be your first objective for using computers. Teach students the names of the parts of the computer and what it can do as a tool, a tutor, or as a tutee (as suggested by Taylor, 1980). Students can also be taught computer languages, BASIC, LOGO, etc. and be given instruction in how to use the computer for self expression, to draw, write, or create computer programs or games. They can be taught the social implications and job possibilities of computers in the community.

Second, tutoring: The microcomputer in the classroom can help children learn concepts, math or other skills, by presenting these to the student and responding to correct or incorrect responses. Drill and practice can be provided for students who need extra help, or remedial work.

The computer can be just an electronic worksheet for drill and practice in alphabet and number recognition for primary grade children, or it can also be playful exploration of ideas, creative learning, experiences in efficacy and problem solving. These kinds of experiences are especially crucial for preschoolers. Sequencing activities, giving directions and generating graphic illustrations can be done by even very young children. To confine the use of the computer in the classroom to remediation or drill and practice would be wasteful for any age, but particularly so for the young child.

Third, programming: Preparing children for a future in which computers will play a major role in their lives can include helping them acquire computer languages, and learning to give the computer instructions. Computer programming may facilitate children's cognitive development, because students become involved in task analyses, recognize more than one way to solve a problem, hypothesize, sequence instructions logically and correct their own errors (i.e., or the program they create won't work). These and other computer skills are appropriate preparation for the computer society of the future and may generalize to other areas of life and learning.

Research by the Center for the Social Organization of Schools at Johns Hopkins University shows that as schools become more experienced with computers, students do more computer programming and less computer assisted instruction. (Report, 1983)

Fourth, open access: Programming a computer or using computer graphics to draw pictures or designs is a powerful mode of self expression. A student can use the computer to make choices, to think creatively, to solve problems, to express ideas with words, pictures, and other symbols.

Ann Piestrup has used computers to teach three- and four-year olds spatial concepts and concepts underlying the acquisition of reading skills. In her research children showed increased understanding of design, composition and use of color through computer graphics. (Piestrup, 1981, 1982) Software programs, touch sensitive panels, joy sticks, paddles, light "pencils" and other special features make software programs in creating graphics fun and easy to do.

Educators may consider games inappropriate for use with school computers, but the creation of games and their rules can be a serious undertaking that includes at least three educative features of computer experience: When students create games on a computer, they combine programming with open access and social learning.

Does the software program go somewhere? (As suggested by O'Brien, (1983). By going someplace, a software program must engage the student in developing intelligent thinking. A simple, straightforward rote memory program on multiplication tables will not meet this criterion. Rote memory practice must be directed toward some motivating application that makes acquisition of the facts compelling.

Examples of available software programs of varying quality that promote children's thinking include "The Factory" which promotes combinational thinking, "Gertrude's Secrets" which promotes inferential thinking and "Taxman" that engages students in the construction of numerical strategies, "Functions" provides, in just a few minutes, experiences in graphing and the first derivative of the function. The computer demonstrates differences, for example, between $y = 3x$ and $x = 3x - 2$ without the student having to coordinate these point by point using pencil and ruler.

Fifth, creative writing: Word processing computers are tools with which students can create their own text and practice reading. Research at Ohio State University in Columbus suggests that children are more concerned about correct spelling when they use word processors than when they write with paper and pencil. (Perrin, 1983) A word processor with print-out capacity can provide students with copies of their creative writing to read and share with peers, classroom newspa-

pers and the like. (For more information about the use of word processors to teach creative writing in the classroom see Standiford et al, 1983)

Sixth, administrative use: This may be an most important rationale for appropriating funds for purchasing the computers in the first place. Accounting, reports, word processing, keeping attendance records, personnel records, grades, tests, budgeting and other management records can be created, processed and stored. A microcomputer can be used in a classroom during the day and by the administrator in the late afternoon and evening. Teachers in Cleveland secondary schools have found the computer helpful in calculating levels of item discrimination, storing and revising teacher-made and other classroom tests.

In order to perform these kinds of administrative as well as classroom tasks, it is necessary to have appropriate software. If software programs selected for use in the classroom meet certain criteria, the teachers and students are more likely to be happy living with their computers. The section that follows discusses seven criteria that can be considered (and need to be researched) in selecting software programs for classroom use.

CRITERIA FOR SELECTION OF SOFTWARE PROGRAMS

First, what type of program is it?

Does its content match the use to which you intend to put it? Is its content valid for those purposes? (c.f. administrative, languages for computer programming, tutoring drill and practice, programming or open access creative activities like graphics, game-making, creative writing, etc.) Will the software format be compatible with the

classroom computer? (e.g., disk, cassette, etc.) What memory, equipment or computer language is required? Will it fit your budget? For what age range of students is the program intended?

Unless your advice is from someone who has actually tried out the program in a classroom with students the same age as students in your class(es), be sure to preview the program before purchasing it. Some manufacturers allow a month's trial before purchase. This is a great advantage in selecting programs for use in the classroom, especially with students who have special needs.

Field Testing

Make the same demand of software programs that are made of standardized tests or curricular materials: Have they been field tested? If so, with whom, when, etc.? For example, field testing of the integration of computer use in the K-8 curriculum during the 1982-82 school year occurred in six schools in Montgomery County, Maryland and in Alexandria, Virginia. Being tested was the guide, titled My Students Use Computers, developed by the Human Resources Research Organization in Alexandria. It covers computer uses in mathematics, science, social studies and language arts. Teachers in at least twenty other school districts also used the guide, participated in this field testing. The guide includes objectives sequenced into six tracks; including, how to use computers and how computers systematize procedural thinking, follow instructions, etc.; introductions to drills, games, simulations, word processing, information retrieval and learning and applying skills in math, science, language arts and social studies; applications of computers in business, science,

government and other aspects of life; social impact and career related opportunities; and writing computer programs.

Second, what will be the psychological impact of this program?

Will this program create stress or anxiety in some students? How much stress and anxiety is too much and how much will be motivating? Is the speed and level of difficulty of the content likely to be a problem for some students?

What is the general psychological mode of the activity provided by interacting with the program? Some programs place the student in a highly competitive mode in which winning and losing may be unduly stressful. If you plan to use the program with learning disabled students or students who have experienced chronic failure, the level of competition or potentials for failure must be considered seriously.

Does the student mainly observe and react or is there interaction? What other kinds of experiences are there besides acquisition of a skill or information?

Some computer games engage the player in acts of violence like shooting at human targets. Will that sort of thing contribute to happiness in the classroom? If the mode is one of simulation, is it life-like or is it so remote as to be down right silly? Are cartoon characters aesthetically appealing or badly drawn?

How much frustration is built into experiencing wrong answers? Does the student get the right answer after two tries, five tries or not at all? Is there a branching program or explanation for the wrong answer, so the student can understand why he or she was wrong? Is it possible to go back and repeat a section of the program if the student wants to do that?

Third, as a sensory experience, how will this contribute to the student's overall perception of life in the classroom? Is the experience enjoyable, relaxing, overstimulating, anxiety-producing, rewarding and in what sensory mode does all this occur? If the software program conveys information, does it do this in a pleasant way with adequate variety, so it doesn't get boring? Older students need larger chunks of text than younger students or they tend to become bored. All students need variety in the manner of interaction. This may be voice, music, graphics, or varying types of questions and text-format. Is it all one mode or is there sufficient variety? Are the sounds pleasant or psychologically abrasive? Will you find the sounds irritating as you live with this program daily, month after month in the classroom?

Screen graphics also contribute to the sensorial satisfaction of a software program: preschool and primary children should have letters of text in adequate size. Readability of the text and good contrast are important features for any age student. Appealing colors and attractive animation can make the difference in motivation for students with learning difficulties, as can adequate provisions for repetition and practice.

Fourth, what physical features make a greater difference for younger than for older students?

Preschoolers may have problems using the joy stick feature of some software programs and may find this unduly frustrating without help. Use of the joy stick requires that the child has internalized body laterality, left-right orientation of body locations. Some programs use one or two keys, a paddle or other graphics manipulation

device, others use only the computer keyboard, and some use combinations of these. Preschoolers can do graphics production and manipulation long before they have learned to type from the computer keyboard.

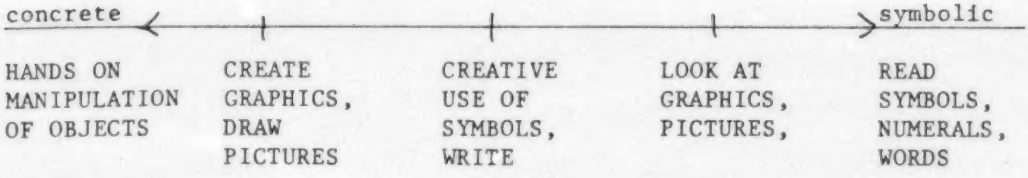
Fifth, open access: Do students have opportunity as they use the program to make choices, to create ideas, words, plans, pictures and other graphics, to pose hypotheses or solve problems?

Open access is perhaps the most important feature to look for in selecting a software program. Don't use the classroom computer(s) only for response-learning, drill and practice. (However, programs of that sort may be especially helpful for remedial work or certain learning disabled students). A software program might be selected because it is enrichment of a topic already introduced in class, allows the student to expand from a basic set of skills or ideas, to apply computer programming language and techniques, or to transfer already acquired knowledge and apply it to other problems.

An example of an otherwise attractive program that lacks open access is the Apple II + program called The Sticky Bear ABC, intended for children three to six years of age. This program has attractive graphics, but requires that the child respond only by pressing one letter on the keyboard, any letter at random. This calls up a letter of the alphabet, a graphic illustration of it and a sound. While it could be used with a group of children or to extend other learning activities, the program is seriously limited in the extent of interactiveness required of the child.

Seventh, how does the software program address the problem of the concrete to symbolic continuum?

This continuum, suggested by the writings of Jean Piaget, Jerome Bruner, Maria Montessori and others is modeled below:



Creative graphics experiences are not an adequate substitute for hands on experiences, but can be suitable in extending or making hands-on experiences more meaningful. In introducing a new topic to students of any age or any topic to young children, it is necessary to begin at the concrete end of this continuum and progress toward the symbolic as the student is ready.

Because the microcomputer is a machine and provides hands-on experience, does not mean that a student typing words with the keyboard and responding to the text on the screen is therefore having a "concrete" experience. On the contrary, typing letters and reading words is largely a symbolic experience.

Curriculum publishers have sometimes led teachers astray in the misconception that including charts and illustrations in texts, in workbooks and in the classroom brings the student's learning experience into the concrete level. Especially for young students and students new to a topic, the computer will not be a substitute for hands-on-manipulation type learning or for experiential-social learning where that its appropriate. Graphics production, and similar activities are important steps toward the symbolic level and many of the newer software programs[5] provide this kind of experiential learning.

It seems reasonable to ask, Do primary age children and preschoolers consider a computer with a screen to be just a television set that responds? Television is already like a third parent for most children and the computer seems likely to be accepted as a natural teacher in this TV mode of instruction. There is a need for more research on questions like this one, especially, with young children. The section that follows will consider some questions about computers in the classroom that need further attention in serious research.

QUESTIONS FOR RESEARCH

Questions that might be addressed by research are numerous: What happens with the computer when the novelty wears off? Is it ignored in the back of the classroom? The halo effect in research with computers in the classroom or at home is a serious problem, because the use of computers in these settings is fairly new.

In what ways can computer programs provide choice, creativity and other aspects of open access? Does experiencing open access increase students' sense of efficacy, power, control and self esteem? What about students who are turned off by the computer, experience failure because a software program is poorly written or does not match the level of the student's ability? What are the implications for students' social learning? (There are now available software programs for use with small groups). What effects can computer use have on social skills? Should the laws about breaking computer codes be required instruction in secondary education?

How can the computer best elaborate or extend the teachers' work with students, especially, with graphics?

What about students whose families have computer learning programs at home? Should they be required to relearn information already acquired on their home computer? How can teachers meet the needs of these individual differences if they are using the traditional mode of instruction?

How is equal opportunity in public education possible when some families can afford to provide for their children academic instruction on home computers and other families cannot?

The increasingly widespread use of computers obviously will change how people learn and what teachers do. Is there as yet any real evidence that use of a computer accelerates academic achievement? If so, what are the variables and how do they influence academic progress (e.g., the relative effectiveness of different software programs, variations in the students' use of the computer, use of home computers, voice simulators versus keyboard, etc.)

How can computers be used most effectively for diagnostic purposes? Almost any software instructional program has some potential for diagnosing students' learning difficulties. Should this be a criterion for selecting a program for use in the classroom?

Many libraries are acquiring software programs that patrons can borrow to use on their home computers. Others have computers to lend. How are computers changing people's reading habits? (A Writing to Read Program in Florida is now studying this question longitudinally.) If most students have computers at home or can borrow them from libraries, perhaps a reasonable question would be not, How can you be happy with computers in the classroom? but, How can you be happy without a computer/s?

Have students become guinea pigs in a gigantic computer education experiment? The dirth of unanswered questions about the uses of computers in education, both in schools and at home suggest how crucial it is that universities, industries and funding agencies initiate more research on computers and the effects of computer learning. Beverly Hunter (1982) charges that "without a scientific basis, educators are investing millions of dollars in hardware, software, training, etc. primarily on the basis of hunches." Many conscientious educators will not be entirely happy with computers in the school until some of these questions are answered and guidelines for using computers in education are more complete.

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